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BELL TELEPHONE QUARTERLY

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BELL TELEPHONE QUARTERLY

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The Meaning of Research to the Telephone Investor

BEGINNING with the invention of the telephone forty-eight years ago a great system of communication has been built up. Today it connects 15,000,000 telephones located throughout the United States and represents an investment of over two billion dollars.

This remarkable development has been brought about in the face of as difficult problems as ever confronted any industry. In the darkest hours of telephone history when problems of many kinds presented an almost unsurmountable barrier to progress, scientific study and experiment constituted the cloud by day and the pillar of fire by night which led the way to the ideal of universal service.

The early years of telephone research proved to be an excellent investment,—during this period the executives learned to put their faith in what was then the new idea of science applied in industry. Telephone research, originated by Alexander Graham Bell, has been constantly expanded until now the staff devoted to development and research in the Bell System numbers three thousand and operates under a budget totaling about $8,000,000 a year.

It has given our country a system of wire communication far superior to that of any other nation. It has made it as feasible for a man in New York to speak to an associate in San Francisco as to any person in his own city. It supplies the means for handling upwards of fifteen billion communications per year. It has placed our central government at Washington in immediate contact with the remotest corner of the nation. It has enabled our Chief Executive, through the agency of the long distance lines and new developments in radio broadcasting, to speak directly to millions of our people.

It is perhaps significant that these achievements should have occurred in a nation dedicated to democracy. By doing these things, the telephone has helped and will continue to help toward amalgamating our people and forming of them one community with common ideals although they are scattered over an area of three million square miles. These people, though coming from every nation and race, are fast being reduced to homogeneity and to the speaking of a single language remarkably free from dialects.

Task of Coordination

In brief, it may be said that applied research has always been incorporated in two distinct but closely related ways in the program of the telephone engineers. It *stimulates* growth by bringing to light new and better devices, processes and methods, and it *directs* growth by choosing those devices, processes and methods which harmonize best with the existing telephone plant.

This two billion dollar plant is like a great living organism in which the functionings of the various parts have been nicely balanced with respect to one another. It has its organs whose proper interplay is absolutely essential to economical operation and the rendering of good service. Of the thousands of separate parts that go to make up the plant, not one can be altered without

involving harmonizing changes in many others. Transmitter and receiver tie to local and toll circuits, to central office common batteries and relays and signaling systems, to telephone repeaters, to superimposed telegraph and carrier telephone facilities, until a single talking circuit of great length, which is set aside for the exclusive use of two persons, may involve as much as three-quarters of a million dollars worth of equipment. A change in one element may echo back and forth through the plant to such an extent that the reports of hundreds of experts in different departments are needed to decide upon the best procedure.

Nor is this all. The telephone plant must show a very low depreciation and much of it must be built in anticipation of demand, even years before the demand has actually arisen. City streets cannot be torn up frequently to lay new conduit and cable, and buildings to house central offices and repeater stations, if they are to be wisely located and proportioned, must be planned in accordance with the most farseeing analyses of population growth and development. For the same reason, faulty design or material in structures and equipment must be guarded against to the limit of human capabilities. If the sheath of cable is given such a composition that when placed underground it is subject to slow corrosion by the elements of the soil or the material of the conduit, large sections of cities, the country over, may be robbed of their service, its repair meaning great expense in digging up streets or removing worthless cable to lay new. And likewise, with loading coils and pots, with the paper used to insulate the separate wires in cable, with poles and their fixtures and other items of plant equipment, provision must be made for long life.

Moreover, to meet the changing trends in the cost of material and the increased cost of labor, intensive work has to be carried out in the modification and improvement of designs of apparatus, in the develop-

ment of more effective and economical methods, and in the judicious substitution of new or different materials. All this requires far more than making verbal modifications in the language of specifications or reducing the amount of material by arbitrary alterations in dimensions or quality. All specifications in the last analysis are based upon economic considerations and considerations of good service. Relative costs of material are constantly changing—at times more rapidly than others—and when the market price of some of those which have been specified becomes excessive, other materials or methods become more economical if technically satisfactory. Changing from one material or one grade of material to another, or from one method to another usually involves experimentation and development work, and often requires new inventions. Frequently it is found that even a very small change from one dimension to another can safely be made only after careful research, experimentation and preliminary practical trials, often on an extended scale. It is always possible to reduce first costs at a sacrifice of service or by incurring increased operating or maintenance expense. The solution of telephone problems requires that these reductions be made without such sacrifices. This is a guiding principle in telephone research.

The Money Value of Research

The sum total of the benefits from research, of inestimable value to the public that uses the telephone, can scarcely be stated in terms of dollars and cents. However, certain individual economies in the methods of construction and operation which research has brought about can be estimated. A few examples—merely typical—will be cited.

Among the many developments which have contributed to the perfection of long distance telephony is the association of apparatus known as the repeater.

In addition to extending this service so that, on land, it recognizes no bounds, it has improved that previously held over shorter lines. It is a device which accurately rejuvenates feeble speech currents by adding new energy to each of the thousands of different frequencies present in amounts exactly proportional to their original intensities. In order to do this a long line is virtually divided into sections or separate lines connected end to end. At the end of each section the repeater takes the feeble energy received and electrically repeats an amplified copy of it to the next section without in any way changing the nature of the voice being propagated. This work is done so effectively that the voice of a speaker in San Francisco is readily recognizable to a friend in Havana even though it has been repeated twenty or more times in its journey over 5000 miles of open wire and submarine cable. The effective length of the whole line is, in effect, that of a single section, and standard sizes of line wire may be used instead of a much larger size which would otherwise be necessary. In the first six years of its use this device brought about a first cost saving in line construction of nearly $100,000,000 assuming that equivalent service could have been rendered by heavier copper wires. The annual charges covering interest, depreciation, maintenance and similar costs showed nearly $13,000,000 saved in 1921 alone. Each of these figures shows a marked increase for each succeeding year due to the increasing use of long distance circuits upon which repeaters are installed. These are the sums which the public would have had to pay, in addition to what it is now paying, for the service it now has, had the repeater not been developed.

Much earlier than the development of the repeater came that of "loading." Starting with the Pupin coil, Bell engineers perfected the loaded telephone line which carries inductance coils at frequent intervals for the purpose of neutralizing effects due to electrical

capacity. These effects might be minimized by using very large wire but such a course would be expensive. The saving to the public yielded by the use of loading coils is therefore to reduce the size of the line wire. In contrast with the repeater, loading does not institute new energy but instead tends to utilize that originally imparted to the line more efficiently. This development has brought about a saving for wire, cable and associated line estimated at about $100,000,000. The saving in annual charges at the present time is about $14,000,000.

This development is of particular interest because much of the research consisted of mathematical analysis, the results of which predicted with great accuracy the characteristics of the loading coils and the frequency at which they should be placed on the line. Although a great deal of laboratory work was required before loading could be placed on a practical basis, it happened, as it frequently does, that the mathematician's complicated equations were quite as useful as the delicate measuring instruments of the experimental technician. In fact, it is only after the involved data from experiment are analyzed and given mathematical expression that they are most useful in solving engineering problems. A single mathematical equation may tell more facts about the life history and peculiarities of an electric wave than volumes of the most skillfully worded narrative.

Research is not always directed toward the solution of major problems such as loading and repeaters. In one case a new alloy was developed for electrical contact points used in telephone apparatus. Inasmuch as each contact point involves a piece of material much smaller than the head of a pin, it may seem that there could be but little saving from any such work. Yet the number of these contacts occurring in relays, keys and jacks is so enormous that in 1921 the development of this new alloy saved buying 8,068 cu. in. of platinum at $898 per cu. in. by substituting a material costing

about $100 per cu. in. The annual charge saving on the material amounted to about $2,500,000.

In a somewhat similar case the composition of telephone cable sheath was changed from 97% lead and 3% tin to 99% lead and 1% antimony. Careful investigation showed that this change could be made without danger of crystallization or erosion and without increasing the cost of manufacture and installation. As the price of tin had risen considerably the change effected a first cost saving of nearly $6,000,000, and an annual charge saving of over $800,000.

A conservative estimate based on only eight developments including those described above shows a saving in initial investment of $465,000,000 and an annual saving of $70,000,000. This alone amounts to approximately $5.00 per year for each telephone in use.

The net results of these savings and the research behind them are two in number. First, the savings represent a monetary benefit which accrues to the subscriber in the rate he pays; if it were not for research a more expensive telephone plant would be required. Second, a more comprehensive and universal service, of which transcontinental telephony is merely a single phase, can be provided than would be possible without the results of research.

Figures Do Not Tell All

These figures merely serve to indicate how developments, wisely undertaken, lead to large economies in the rendering of a given service. They do not in any way represent the grand total of savings which may be credited to the research and development staff. No account has been taken of the carrier current apparatus which enables as many as five telephone messages or twenty telegraph messages to be transmitted simultaneously over the same long distance circuit, nor does it include the principle of compositing which

permits an ordinary long distance telephone circuit to carry four telegraph messages in addition to the usual telephone message.

Neither are these figures, large as they are, an adequate measure of the value of the developments to which they explicitly refer. In any evaluation of research it must be borne in mind that time is an important factor. Although a particular device is usually developed to fill a particular need or to permit of extending the service in some one respect, it frequently happens that, as time goes on, uses are found for it which were not contemplated at the time of its development.

An illustration is found in the thermionic tube which was developed for the telephone repeater, a purpose for which many thousands are now in use throughout the system. Once the tube had been perfected it was found applicable to radio telephony in a very fundamental way. One of the major problems which had to be overcome before telephony without wires could be carried on was the control of large amounts of electric power by the almost infinitesimal power of the voice. This the tube accomplished by supplying very efficient oscillators, modulators, detectors and amplifiers. In addition to the tube, much of the equipment of radio has been borrowed from the wire telephone art; for example, such parts as transmitters, transformers, receivers and loud speakers. Indeed, our engineers were in such a strategic position that the establishment of radio telephony in its modern form was very largely their work. As early as 1915 they transmitted the voice across the Atlantic for the first time, an achievement which marked man's triumph over the last great barriers to long distance telephony—the oceans.

Research as an Aid to Directing Growth

As mentioned earlier, one of the chief functions of research is to supply the information necessary for

wisely guiding the growth of the telephone plant. It must reduce the danger of false steps by supplying to the technical staff a wide vision of the different courses that can be pursued to a given goal so that the potentialities of each can be appraised with accuracy. The research staff is therefore constantly working over the fields of science which are in any way related to electrical communication and accumulating a reserve fund of information upon which future judgments can be based.

To illustrate: having brought the radio telephone to its modern and practicable form, the question at once arose as to the future application of this remarkable method of projecting the voice through space. Since their original demonstration of transoceanic radio telephony in 1915, the research and development staff has studied the possibilities of wireless transmission intensively. In their studies they have applied it in an experimental way to ship-to-shore communication and for work between fixed points where wires are impracticable. They have built broadcasting and receiving apparatus and are actively participating in this new art. They are also following up their initial success in the transatlantic field. Coming during the World War conditions made it impossible to carry the work further at that time, but it has been resumed during the past two years with notable success. The engineers have developed apparatus capable of rendering transatlantic service under favorable conditions. They have also investigated the transmitting characteristics of the ether for every month in the year to find what hindrances are imposed by nature upon the sending of telephone messages across the Atlantic and how best to cope with these in such a way as to render commercial service. The magnitude of this problem can be illustrated by stating that the amount of power necessary to maintain a fixed level of reception may change by as much as 10,000 times in the space of but a few hours.

The submarine cable for transoceanic telegraph com-

munication has also been the subject of extensive investigation and immense improvements have been effected. These have come about through the discovery of a new magnetic alloy which is destined to have far-reaching effects in many branches of communication. In the course of a systematic investigation of magnetic materials it was found that the combination of about 20% iron with 80% nickel, when properly heat-treated, possesses remarkable magnetic properties. For instance, the readiness with which it propagates magnetic lines of force is approximately two hundred times that of soft iron. This material is now being used in the construction of a new submarine cable which will have a message capacity four times that of the cables at present in use. Prior to this development the technique of cable making and operation had not been substantially modified in fifty years.

Research and the Investor

In forecasting problems and supplying their answers, the development and research staff functions as a reconnaissance agency which thoroughly investigates the future, keeping the operating and service branches of the telephone army which are to follow supplied with exact information as to the technical and industrial terrain over which they will pass. In this way the objectives of the future can be planned and attained with much greater facility and economy than would otherwise be possible.

Research helps to give not only better service at a reduced cost to those who use the telephone but also increases the variety of services offered. It is important, therefore, not only to the executives of the System but to the telephone user because it assures him the best service our knowledge of natural laws makes possible. It furthermore safeguards the investor and assures him that those spending his money have the

broadest view of what science holds in store and that, as new discoveries are made, they will be woven into the plant, which his money has built, with the maximum of efficiency and economy and in such a way as to yield the best returns.

There are several methods of depicting a corporation's business and financial standing. One of these, and perhaps the one most usually appealed to, is the balance sheet. But the balance sheet tells of the past while research forecasts the future; and the Bell System, while proud of its balance sheet, faces the problems and opportunities of the future with the largest research and development staff in the world, with a successful record of achievement behind it.

R. W. KING.
G. C. SOUTHWORTH.

NOTE:—Dr. King and Dr. Southworth are of the Information Department of the American Telephone and Telegraph Company.—*Editor.*

Telephone Development in the United States and Abroad

IT was a very pretty compliment that the Postmaster General of New Zealand paid to the American telephone companies a year or so ago. He said, if newspaper reports quote him correctly, that the telephone service "in the United States of America... is recognized as the most efficient service in the world."

This generous tribute was notable as coming from the head of a telephone system which has itself attained a creditable position among foreign wire services. New Zealand, although a new country whose vast potentialities have hardly begun to be developed, has already built up its telephone service to such an extent that, according to the latest figures available, it is surpassed in number of telephones relative to population only by the United States, Canada and Denmark. New Zealand's telephone system is noteworthy, also, for the fact that, unlike many foreign systems, it shows no excessive preponderance of urban over rural facilities. The New Zealand Post Office has, to be sure, been criticized more than once in the Parliament of the Dominion for not pushing telephone construction more vigorously in the "back blocks," or sparsely settled regions of the interior. Yet the latest statistics at hand show that in places of less than 10,000 population the New Zealand system has a development of about 7 telephones per 100 people, while in places with over 10,000 inhabitants the development is approximately 8.6 telephones per 100 population. These figures indicate that telephone facilities in the rural districts of New Zealand are relatively more extensive than those in most other sparsely settled regions, outside of North America.

America's Telephone Leadership

The fact that the United States has a telephone system unapproached in magnitude by that of any

other country is well known. Certain elements in America's telephone accomplishment can, of course, be statistically measured and compared with corresponding figures for foreign telephone systems. Among these elements are the large number of telephones in this country, both absolutely and in proportion to population; the high telephone development, not only in large cities, but in small places as well; the huge mileage of telephone wire; and the tens of millions of telephone conversations which take place each day.

Yet, in a sense, America's leadership in the telephone field is not capable of statistical appraisement. The "telephone habit" is so woven into the warp and woof of American civilization that figures, however striking, are but a dull reflection of the part which the telephone plays in the daily life of every American community. To say that the telephone is indispensable, not only in the business, but also in the social intercourse of this country, is so trite that it is difficult for Americans to realize that great, civilized and otherwise progressive foreign nations do not place nearly as much reliance upon the telephone as we do. The greater use made of this means of communication in the United States in turn gives it a greater usefulness, and this again causes it to be still more extensively employed. The gain is reciprocal and cumulative. Where practically everyone is accessible by telephone, and where the use of the telephone in all manner of transactions is sanctioned by custom, the value of a telephone is immeasurably greater than in countries where these conditions do not obtain. The fact that in the course of a year there are over 160 telephone conversations per capita in the United States, as against fewer than 52 in Germany, and less than 18 each in France and Great Britain, is an indication of the extent of the telephone habit in this country.

Nor do statistical comparisons of telephone development in the United States and abroad bring out the

differences in the character of the service rendered. In nearly all foreign countries, for example, the telephone service, outside the larger cities, is operated only during stipulated business hours and is not ordinarily available at night nor during the greater part of the day on Sundays and holidays. The "booking" of long-distance calls on a waiting list, and the imposition of charges for "urgent" long-distance calls amounting to two or three times the ordinary rates, are also among the features that sharply differentiate the telephone service in many countries from that in the United States. These differences are, of course, not revealed by comparative statistics as to number of telephones per hundred population. They may, however, account to some extent for the fact that the telephone is not as popular abroad as it is here.

The achievements of telephone research, also, are not susceptible of comparison in quantitative terms. The untiring labors of the telephone engineers who have made possible universal, nationwide service as Americans know it, the innumerable ingenious devices which they have produced, the scientific methods of telephone operation which they have formulated,—all these are important elements of telephone achievement which cannot be statistically measured.

The Spirit of Service

There is another and yet more vital element of telephone accomplishment which wholly eludes statistical presentation. It is that intangible, but intensely real thing—the human element in the telephone organization. For the telephone is essentially an instrument of personal service, and its usefulness to the public is peculiarly dependent upon the spirit which animates the telephone personnel. Whatever has been accomplished here toward realizing to the full the inherent possibilities of the telephone for public usefulness is due, not only to the existence of this spirit, but also to

the fact that in the United States it has been given free rein to work without the handicap of restrictive conditions. It is unfortunately true that in certain other countries the telephone has never attained its maximum usefulness even within the relatively limited sphere to which it has been restricted. This has sometimes occurred even where there has been no lack of devotion or enterprise on the part of the responsible telephone executives. In such cases it has been due, rather, to the fact that in these countries telephone officials have been compelled to labor under conditions which, to a greater or less degree, have cramped the exercise of their initiative and repressed the spirit of service that was struggling for expression.

To what extent American supremacy in telephone development is attributable to the freedom which has been accorded in this country to private enterprise is, of course, not capable of exact determination. Foreign commentators frequently tend to ascribe it rather to the progressive qualities of the American people, who are ever eager to embrace new methods and to employ labor-saving devices of every kind. It would be idle to deny that this characteristic American trait has been an important factor in popularizing the telephone in the United States. Yet there is reason for believing that certain other countries might have attained a much higher telephone development and plane of service than they have actually reached, had they given to the driving force of private initiative the same freedom in the telephone field which it has enjoyed in America.

Some Pertinent Figures

So far as they go, the figures speak for themselves. The United States has about 6% of the world's population, and 63% of the world's telephones. On January 1, 1923, the latest date for which comparative figures are available as to telephone development in the prin-

cipal countries, the United States had 13.2 telephones for every 100 people,—a record unequalled anywhere else in the world. Canada had, at that date, 10.4 telephones per 100 inhabitants, Denmark 8.3, Sweden 6.6, and Switzerland 4.3. The great European Powers lagged far behind. Germany had only 3.5 telephones for each 100 persons; Great Britain had 2.2. The French and Italian statistics at hand are not quite so recent; but on January 1, 1922, France had only 1.3 telephones for every 100 inhabitants, and Italy but 0.3. The average for the whole of Europe at that date was 1.2 telephones per 100 population.

Japan, despite her readiness to adopt new devices, had, even prior to the recent disaster, only about 1 telephone for each 100 people. In the progressive forward-looking Commonwealth of Australia there were, on June 30, 1922, the latest date for which figures are available, only 4.6 telephones for every 100 inhabitants. New Zealand, also preeminently a new country with its eyes on the future, had, by March 31, 1923, attained a development of 8.1 telephones per 100 people.

These figures emphasize what the Postmaster General of New Zealand has called "the extraordinary preponderance of telephones in the United States of America." It should not be overlooked, furthermore, that the country in Europe that approaches nearest to the United States in number of telephones relative to population is Denmark, in which a large majority of the telephones are owned and operated by private enterprise. In the United States, which leads the whole world in telephone development, the entire telephone system of the country has, of course, been built up by private enterprise from the beginning. The results are such that he who runs may read.

European "Conservatism"

Comparisons of this kind, however, are sometimes criticized abroad as unfair. It is contended that lack

of progressiveness among Europeans, rather than the existence of government ownership, is responsible for Europe's having reached in 1923 only a stage of telephone development attained by the United States in 1900.

Yet Europeans generally, at least in the more advanced countries, regard ubiquity of the telephone as a goal at which to aim. This is apparent from the great number of editorial and other expressions which have appeared in the British and Continental press during recent years. The British Post Office, in particular, has been criticized again and again in English newspapers for not pushing the expansion of the telephone system more vigorously. It has been lectured repeatedly in the press because the telephone is not found in "working-class" or, in fact, in many "middle-class" homes in England. It has been exhorted to strive for the glad day when the telephone will be as indispensable as the bath. If the press correctly reflects British sentiment, it is the popular desire that the telephone shall become as intrinsic an element of business and social life in England as it is in America.

The argument that the people of Great Britain are too conservative to make full use of such an instrumentality as the telephone underrates the sterling qualities which have given Britain her commanding position, both in trade and in the intellectual life of the world. Surely the land that produced Watt, Wheatstone, Faraday and Lord Kelvin is not to be described as unprogressive. Any American, furthermore, who takes the trouble to inform himself on the subject, will be compelled to admit that some of the countries on the Continent of Europe are in advance of the United States in certain phases of scientific achievement,—although assuredly not in telephony. It would be mere bumptiousness on our part were we to stigmatize as unprogressive, nations that have given to the world such scientific leaders as Pasteur, the Curies, Marconi

and Einstein,—to mention but a few of the distinguished names that come to mind.

To be sure, the telephone must find its clientele among the population at large, and not merely among the intellectual leaders. Yet few will deny that the general standards of education are higher and the requirements more exacting, not only in the universities, but also in the schools, of France, Germany, Great Britain and certain other European countries, than they are in most of the corresponding institutions in the United States. European immigrants in this country acquire the "telephone habit" quite as readily as other American customs, and frequently become telephone users almost as soon as they learn English. The contention, therefore, that the people of the great European nations are too backward and unprogressive ever to make very extensive use of the telephone seems hardly tenable.

The Argument that Conditions are not Comparable

It is sometimes argued, however, that it is an economic impossibility for European telephone systems to be developed on a scale commensurate with American standards. "One really cannot compare," said a recent English commentator, "the facilities (in Great Britain and the United States), which largely arise from the differences in the standard of living in the two countries. There, in almost every artisan's house when he takes it, there is a telephone, which is an entirely different state of things from anything we have in this country."

It is, nevertheless, a state of things which the British press gives evidence of heartily desiring to have in that country. Of course, it cannot be denied that the general standard of living, particularly among wage-earners, is higher in the United States than it is in most foreign

countries. It would be a mistake, however, to attribute to this influence the whole of America's leadership in telephone development. There is good ground to believe that unimpeded private enterprise, even though it might not have been able to equal in Europe the record of telephone development which it has achieved in America, would nevertheless have given to certain countries a considerably larger number of telephones in proportion to population than they have ever been able to attain under government ownership.

International comparisons as to the number of telephones per 100 population have also been criticized as unfair because of differences in topography and in the size and distribution of the population in various countries. As the number of telephones per 100 people is simply a ratio, it would seem that differences in the absolute size of the population in different countries would be immaterial in this connection. Moreover, within the limits of the continental United States there may be found every possible distribution of population, from enormous cities to isolated homesteads, as well as topographical conditions duplicating or surpassing the most difficult features, from a telephone standpoint, to be encountered in any country of Europe.

Long Distance Telephone Service

The immense distances, for example, by which important communities in America are separated, have interposed physical barriers to telephone communication, but these obstacles have been overcome. Yet in Europe, despite the comparative density of population, telephone conversation is still impossible over distances equivalent to those covered by many of our long distance circuits. "International telephony as yet is in its infancy," said an article in the London *Times* a year or so ago, "but business houses in London have already realized the value of the existing system, and a few

people have actually anticipated the romantic potentialities of a Continent completely linked up by telephone." On the Continent of North America these "romantic potentialities" have become an accomplished fact.

The *Times*, again, is authority for the statement that, although British firms with branches in cities like Paris, Berlin, Brussels, and Milan, can, by having these branches receive and retransmit their telephone messages, use the present long-distance telephone lines to cover practically the whole of Western and Central Europe, this "is only made possible by the employment of staffs in the relaying centers," and "the complications are beyond the resources" of the ordinary business man. It is as though an American firm were obliged, if it wished to telephone from New York to Minneapolis, to maintain its own agents at, say, Pittsburgh and Chicago, to repeat or "relay" the call. During the past year plans for the improvement of the long distance lines have engaged the attention of European telephone experts, and the matter has been discussed at international conferences. At last accounts, however, the entire mileage of telephone wire, local and long distance, in all the countries of Europe combined, was slightly less than half of that in the United States.

Urban and Rural Telephone Development

While national boundaries and differences of language are, of course, partly responsible for the backwardness of long distance telephony in Europe, these factors do not account for the relatively small telephone development within the individual countries. Nor are they responsible for the concentration of telephones in the larger cities. According to the latest figures available, one-third of all the telephones in France are in Paris, and London possesses one-third of all the telephones in Great Britain. Notwithstanding this tendency toward

the concentration of telephone development in the large urban centers, Europe has but seven cities with over 100,000 telephones each, as compared with fourteen cities in the United States that have over 100,000 telephones apiece. In relation to population the contrast is even more marked. On January 1, 1923, London had 5 telephones for every 100 people; Berlin, 9.3; Hamburg, 9.8; The Hague, 7; Brussels, 3.8; Prague, 3.3. At the same date, Washington had 22.8 telephones for every 100 inhabitants; Chicago, 22.3; Des Moines, 26; Omaha, 28; and San Francisco, 25.2. The only large European city in which the telephone has been developed to a degree comparable to American standards is Stockholm, where the system was built up some years ago largely by the aggressive efforts of the Stockholm Telephone Company.

Although the urban telephone systems of Europe are thus relatively under-developed as compared with those in the United States, telephone facilities in the smaller places are still more restricted. This has a very real influence on the usefulness of the telephone as a factor in national life. Thus, for instance, the statement that, at a date (January 1, 1922) when the United States had one telephone for every 8 inhabitants, Germany had only one telephone for every 29 people, gives but a faint idea of the relative scarcity of telephones in the smaller communities of Germany. For while there was, at last accounts, one telephone for every 7 persons in German cities and towns of over 10,000 population, there was only one telephone for each 117 inhabitants in the places of less than 10,000 population. So also in France, communities with a population of less than 15,000 had but one telephone for every 185 persons, while those with over 15,000 population had one telephone for each 32 people. Nor are these isolated instances; similar conditions might be cited in other European countries.

The dearth of telephones in the the smaller towns

abroad is accentuated in the agricultural districts. Farmers' telephones, which have played such a large part in the development of rural America, are almost unknown on the Continent of Europe. Even in agricultural Australia, at last accounts, places of less than 10,000 population had only one telephone for every 27 people, while those of over 10,000 population enjoyed one telephone for every 15 inhabitants. Again and again, in the Australian Parliament, members have appealed to successive Postmasters General for extensions of telephone facilities in the "back-blocks," as one means of stemming the drift of population to the cities. More than once Postmasters General have felt obliged to reply that the government was not prepared to spend the money. During the past few years, however, the Australian Post Office has considerably reduced the financial guarantees which it requires before undertaking the construction of rural telephone lines.

America's Unique Achievement

In the building of farmers' telephone lines, America's record still stands alone. Approximately two million seven hundred thousand farm dwellings, or nearly one-half of all the rural homes in the United States, are already equipped with telephones. These figures apply to the country as a whole, which, of course, includes a large number of farms occupied by immigrants, negroes and illiterate native whites.

This remarkable achievement has unquestionably been facilitated by the energy and progressiveness which are characteristic of the average American farmer. A large proportion of the farm telephones in the United States are on lines constructed by cooperative associations or small companies organized by the farmers themselves, which connect with the systems of the larger telephone companies and through them with the long-distance circuits that span the Continent. This

method of rural telephone construction has given very satisfactory results also in Canada. The possibility of its adoption in Great Britain, in a modified form, was brought to the attention of the British Post Office in the Report of the (Parliamentary) Select Committee on the Telephone Service, 1922; and a similar plan was recommended in France, at about the same time, by the Committee on Public Works and Means of Communication of the Chamber of Deputies. In each country, however, the government declined to avail itself of the cooperation of private enterprise in the telephone business.

Some Disadvantages of Government Ownership

It is not surprising that the telephone has in no country attained, under government ownership and operation, a development equal to that achieved under private enterprise in the United States. Government departments lack incentives to seek business. The necessity for monetary profit is a stimules without which the average enterprise will not do the best work. In governmental undertakings this stimulus is, of course, wholly absent.

There are exceptional men, however, who need no other incentive to effort than the spirit of service and progress that is in them. Government telephone departments have often been fortunate in commanding the services of such men. It is a pity that, as government officials, they should be handicapped in dealing with their subordinates, either by political pressure or by the rigidity of civil service regulations which, in order to abolish favoritism, abolish also freedom in the selection, promotion and dismissal of employees.

The political system, moreover, places at the head of a highly technical service a cabinet minister who is almost always without telephone experience, and whose

selection as a rule involves important political considerations. A change, too, in the political fortunes of his party may deprive a cabinet member of his portfolio almost before he has had time to become familiar with the work of his department. A case in point is the Postmaster Generalship of Great Britain, which was held by four different incumbents between October, 1922, and the end of May, 1923, and which has since changed hands again.

Frequent changes in the responsible head of a service make it extremely difficult to carry out any plan of development requiring continuity of administration over a period of years. Furthermore, government telephone officials have frequently met with disheartening failure in their attempts to secure from the Treasury and from Parliament funds adequate for necessary additions and betterments. The telephone service is brought into competition with other government departments seeking funds for civil or military purposes. The consequent tendency for Treasury officials to reduce the telephone estimates has been accentuated in various countries by the fact that even expenditures for new construction have had to be financed principally by legislative appropriations. Telephone financing is thus controlled by the Treasury and ultimately by Parliament,—not by the telephone officials who are responsible for the efficiency of the service. Under such circumstances, failure aggressively to solicit business or to push telephone construction beyond the actual requirements of the moment, is thoroughly understandable. The concentration of telephones in the larger cities abroad and the general reluctance to expand telephone development in the less remunerative areas are apparently due, in large part, to the difficulty of financing extensions, which is intensified in certain countries by recurrent deficits incurred in telephone operation.

In view of the obstacles that confront government

telephone executives who are compelled to operate without continuity of administration and without free control either of the telephone personnel or of telephone financing, it is not strange that they should sometimes manifest a tendency toward excessive routine and loss of initiative. These conditions seem to offer an explanation, also, of the somewhat arbitrary attitude toward the public which the press of certain countries attribute to their government telephone bureaus.

One Cause of America's Leadership

The degree of telephone development which has been attained in certain countries, despite the handicaps inherent in public ownership, speaks volumes for the energy and ability of the telephone executives. If it has still fallen far short of what might have been attained had the management been allowed a free hand, it is not generally the officials, but the system of governmental administration that is to blame.

After all due allowance has been made for the progressive character of the American people, it is still apparent that freedom from the restrictive conditions which hamper the development of telephone systems under government ownership is responsible for a large part of "the extraordinary preponderence of telephones in the United States of America."

Richard Storrs Coe.

Note:—Mr. Coe is of the staff of the Chief Statistician of the American Telephone and Telegraph Company.—*Editor.*

Obligations Under the License Contract

THE telephone business had its inception in the invention of Alexander Graham Bell. The license contract, licensing the Associated Companies to use the Bell patents, is the fundamental basis of the Bell System organization. It determines the structure of the Bell System, and provides for universal service to be secured through a combination of two separate services; one to be rendered by the American Company, and the other by the Associated Companies.

In addition to the licenses under the original patents and thousands of later ones this contract provides for vitally important services to be rendered to the Associated Companies by the American Company. Beginning with the instrument service, the scope of these services has broadened with the development of the art, until they now include whatever assistance is necessary to the most efficient and economical development of the telephone service in the United States.

The license contracts are all identical in their basic provisions. A summary of the obligations of the American Company and of the Associated Companies under these contracts, accurate except in the omission of some minor details not essential to a comprehensive view of the situation, follows:

A. Obligations of the American Company

1. Instrument Services.

The American Company undertakes to provide an adequate supply of telephones and to deliver them to the Associated Companies as needed by them, and as selected by the Associated Companies from the standard patterns of the American Company.

The Associated Companies are licensed (a) to use such telephones and to grant to their patrons and certain others the right to use them in their respective

territories, including their use upon the lines of the exchanges of the Associated Companies, upon extra-territorial connecting lines, and in connection with certain of the trunk or long distance lines of the American Company; (b) to permit their use upon the lines of sub-licensees and connecting companies, and upon farmers' and like lines and upon lines operated by railroads; and, (c) to use them upon private lines and the lines of private inter-communicating systems.

The right of the Associated Company to use these telephones within its territory is exclusive, with minor exceptions, except as against the long distance lines of the American Company; but is upon the condition that the Associated Company shall satisfy all reasonable demands for exchange and toll line service within its territory at just and reasonable rates.

The American Company undertakes to replace and repair all defective telephones returned to it, and to furnish without charge all parts for making replacements in telephones which the Associated Company has in service or on hand.

2. Services in Connection with Telephonic Apparatus, Appliances, Methods and Systems.

The American Company undertakes to license the use of inventions in call-bells, switches, switchboards and other telephonic devices, apparatus, methods and systems needed for the telephone lines of the Associated Company upon the same terms to it as to others under like circumstances.

It also agrees to permit the Associated Company to use all telephonic devices, apparatus, methods and systems covered by the American Company's patents; with the right to use, when completed and standardized, all new and improved apparatus and developments in the art of telephony resulting from the research and experimental work of the American Company.

It further undertakes to render available for use by the Associated Company all products of the American Company's development and research work and all apparatus, appliances, methods and systems embodying inventions, discoveries and patents relating to the art of telephony and recommended for use by the American Company.

3. Use by the Associated Company of the American Company's Rights of Way, Overhead and Underground Facilities, etc.

The American Company gives the Associated Company the right to use any of the American Company's rights of way and similar franchises, including the use of the American Company's overhead and underground facilities, so long as such use shall not interfere with the enjoyment thereof by the American Company or the other Associated Companies; this use to be subject to the consent thereto of Public Service Commissions, if such consent is required by law.

4. Patent Protection.

Without expense to the Associated Company, the American Company undertakes to defend and insure the Associated Company against judgments for damages in all actions against it for infringement of patents arising out of the use by it of telephones furnished under such contracts or of any apparatus, methods or systems which the American Company may recommend.

It also undertakes to render advice and assistance in patent matters.

5. Development and Research.

The American Company undertakes to continuously prosecute the fundamental work of research, investigation and experimentation in the development of the art

and science of telephony, and in the development of plans, methods, systems and ideas for the promotion of, and safety, economy and efficiency in the equipment, construction and operation of the telephone plant of the Associated Company and agrees to direct certain development work to be done by others.

6. Advice and Assistance in Connection with the Conduct of the Associated Company's Business.

The American Company undertakes to give advice and render assistance in general engineering, plant, traffic, operating, commercial, accounting (including the auditing of accounts) patent, legal, administrative and other matters pertaining to the efficient, economical and successful conduct of the Associated Company's telephone business.

7. Financial Services.

The American Company undertakes to give advice and render assistance in any financing required to be done by the Associated Company in the extension, development or improvement of its telephone system and in the general matter of its finances; to aid in securing funds for it on fair terms for new construction and other expenditures; and to render active assistance in marketing its securities.

8. Long Lines Connections and Service.

The American Company undertakes to give to the Associated Company the right to extend to its subscribers and other patrons and to those of its connecting companies the privilege, upon the payment of the regular tolls, of using the lines of the American Company for communication to and from one another's subscribers, including those of their connecting companies, and, continuously to construct, maintain and extend for such use the proper circuit and other facilities for

connections between the territories of the different Associated Companies.

9. Services in Connection with Employees' Welfare.

The American Company undertakes to render to the Associated Company active assistance, cooperation and support in the adoption of measures for the protection and preservation of the health and to promote the well-being in employment of its employees, and, continuously to maintain, at not less than its original amount, the fund established by the American Company in its "Plan for Employees' Pensions, Disability Benefits and Death Benefits," with the right to the Associated Company to have recourse to that fund in case of a deficiency in the fund established by it under its "Plan for Employees' Pensions, Disability Benefits and Death Benefits."

10. Extension of American Company's Engineering and Technical Advice to Connecting Companies.

For the betterment of the service in its territory, the American Company undertakes to give to the Associated Company the right to extend to its connecting companies, on terms and conditions to be determined by it, the benefit of any engineering and other technical advice and information relating to the construction, maintenance, repair and operation of plant, which the Associated Company may receive from the American Company.

11. Central Headquarters Staff.

The American Company undertakes to maintain continuously an organization of specialists trained in the various branches of work to be done by the American Company in rendering the various services above mentioned, sufficient in number, and equipped with adequate technical knowledge and experience.

B. Obligations of the Associated Companies Under Such Contracts

1. Connections by Associated Company with Trunk Lines Reserved to the American Company.

The Associated Company obligates itself, unless specially authorized by the American Company, not to directly or indirectly connect any line or telephone exchange with the trunk lines reserved to the American Company.

2. Disposal by the Associated Company of Telephonic Devices, Apparatus, Methods and Systems which it is Licensed by the American Company to use.

The Associated Company is obligated not to dispose of the telephonic devices, apparatus, methods and systems described in Article 3 of such license contracts without the consent of the American Company, except to those licensed by the American Company to use the same or to the licensed manufactures of the American Company.

3. American Company Trunk Lines; Use by American Company of Associated Company's Overhead and Underground Facilities, etc.

The Associated Company grants the American Company the right to enjoy certain of its rights to construct and maintain trunk lines from its several exchange offices to points outside of such exchanges, and also grants to the American Company the right to use certain of the Associated Company's overhead and underground facilities.

The Associated Company admits the right of the American Company to use telephones on lines passing over the routes of the lines of the Associated Company, but connecting places with which the Associated Company is not authorized to connect. The Associated Company obligates itself to permit the American Com-

pany to connect the wires of any such lines with its lines in order to make up a through line.

The Associated Company is also obligated to make convenient switchboard or other connections for the purpose of passing communications over such through lines, and agrees to take as its compensation for the use of its lines in this connection and for making such connections a share of the through toll prorated according to distance; it also agrees to require the subscriber to bind himself to pay the tolls for such communications and to hold the American Company harmless from all loss or expense growing out of such communications. This use is subject to the consent thereto of Public Service Commissions, if such consent is required by law.

The Associated Company is obligated to permit the American Company to enter its offices and connect its exchanges with any point either within or without its territory with which the Associated Company is not permitted to connect; it also obligates itself to permit the American Company to operate such lines and agrees to permit its patrons to use the same; it also agrees to make the switchboard and other connections to facilitate such communications, if requested by the American Company, and to permit the American Company, if it is not satisfied with the manner in which the Associated Company handles such communications, to establish its own offices and trunk and radiating lines for the purpose of transmitting such communications.

4. Routing of Messages, Amount of Commissions on Same to be paid Associated Company, etc.

In so far as the Associated Company can lawfully control the routing of messages, it obligates itself to cause its exchanges to route over the lines of the American Company, and of its appointees, all communications to points outside the Associated Company's territory, and in some cases to points within its territory. The cases last mentioned are exceptional, arising out of com-

binations of license contract territories through consolidations.

The Associated Company agrees to render an accounting to the American Company as to each such communication and to collect and pay over to the American Company, or its appointees, the tolls due it on such communications; to keep and exhibit to the American Company records of such communications and to handle such interchanged business according to the operating methods and rules established by the American Company.

The Associated Company obligates itself upon request of the American Company, to make proper switchboard and other connections between its lines and the lines of the American Company for the purpose of making up a through line to points without the exchange area of the Associated Company.

5. Telephones Detained, Lost or Destroyed.

The Associated Company agrees to pay the American Company a sum not to exceed $5.00 for any telephones which are unlawfully detained by the Associated Company or lost or destroyed otherwise than by fire or unavoidable casualty. The Associated Company agrees that such payments shall not give it the right to such telephones or to their use or prevent the American Company from obtaining possession of such telephones.

6. Excess Instrument Parts.

The Associated Company obligates itself to return all excess instrument parts to the American Company.

7. Patents.

The Associated Company admits the validity of all patents regarding telephony and telephonic devices now or hereafter held by the American Company or under which it may hold exclusive licenses, and agrees

not to dispute the validity of such patents or licenses or the American Company's title thereto.

8. Payments.

The Associated Company agrees to pay for the telephones, services, licenses and privileges furnished to it under such license contracts 4½% of its total gross earnings, subject to certain specified deductions; such payments to be made in monthly installments. The Associated Company is also obligated to make similar payments for its sub-licensees or their connecting companies in which such Associated Company owns a majority of the capital stock. It is provided, however, that under certain circumstances, the Associated Company may apply to the American Company for the remission in whole or in part of the payments based on the gross revenues of any such sub-licensed or connecting company.

The Associated Company agrees to render periodical reports to the American Company, showing the number of telephones in use and in stock in its territory and agrees to make the license payments to the American Company in New York or Boston funds periodically on dates fixed; the Associated Company also agrees to make such further statements of telephones in use or in stock as the American Company may request. The Associated Company also obligates itself to make such reports to the American Company relative to the operation of its exchanges and lines as the American Company may from time to time request.

Under the reciprocal provisions of A, 3 for the use of American Company facilities by the Associated Company, and of B, 3 for the use of Associated Company facilities by the American Company, each company making such use is required to pay a reasonable compensation therefor based upon cost. Where lines of the Associated Companies are used in making up long distance lines, the Associated Company is com-

pensated by the American Company through a prorate of revenue. For what is done by the Associated Company in connection with the long distance service, the Associated Company is compensated by fixed payments made by the American Company. The use of the Associated Company's facilities in establishing connections between an exchange station and a toll switchboard is part of the Associated Company's local exchange service, for which it is paid through its exchange rates.

9. Default, Bankruptcy or Insolvency of the Associated Company.

Provision is made for the termination of the contract in the event of the default, bankruptcy or insolvency of the Associated Company; otherwise, the contract is to be permanent.

Where the contract is terminated, the American Company is given the right to purchase the telephone property of the Associated Company in the territory covered by the contract.

10. Assignment.

The Associated Company has not the right to assign the contract without the written consent of the American Company.

N. T. GUERNSEY.

Accounting in the Long Lines Department

IN addition to the basic responsibility of auditing receipts and expenditures, it is the function of an Accounting Department to establish a system of accounts applicable to the business concerned; to collect and record the data required by the accounts; to analyze and interpret the assembled figures; and to present the determined facts in a clear and comprehensive manner through the media of statistical reports, graphic charts, or narrative statements. By means of these reports and charts, executives and operating officials are able to trace significant developments, to compare actual performance with expected results, to set the present record of accomplishment beside the attainments of past periods in order to measure the progress or change, and, finally, to prepare forecasts and plans for the future based on known conditions and trends.

The Long Lines Accounting Department, in common with the Associated Companies, uses the standard Bell System accounts, which are based on the requirements of the Interstate Commerce Commission, prepares the reports and follows the general methods and policies developed by the Comptroller's Department of the American Telephone and Telegraph Company, which have been effective in making the accountants of the Bell System active participants in the current affairs of their respective companies.

Distinctive Features of Long Lines Accounting

Long Lines accounting, however, differs in some respects from the accounting work of most Associated Companies, due to the problems incidental to the wide extent of the territory served, the absence of exchange service accounting, certain unusual features of Long

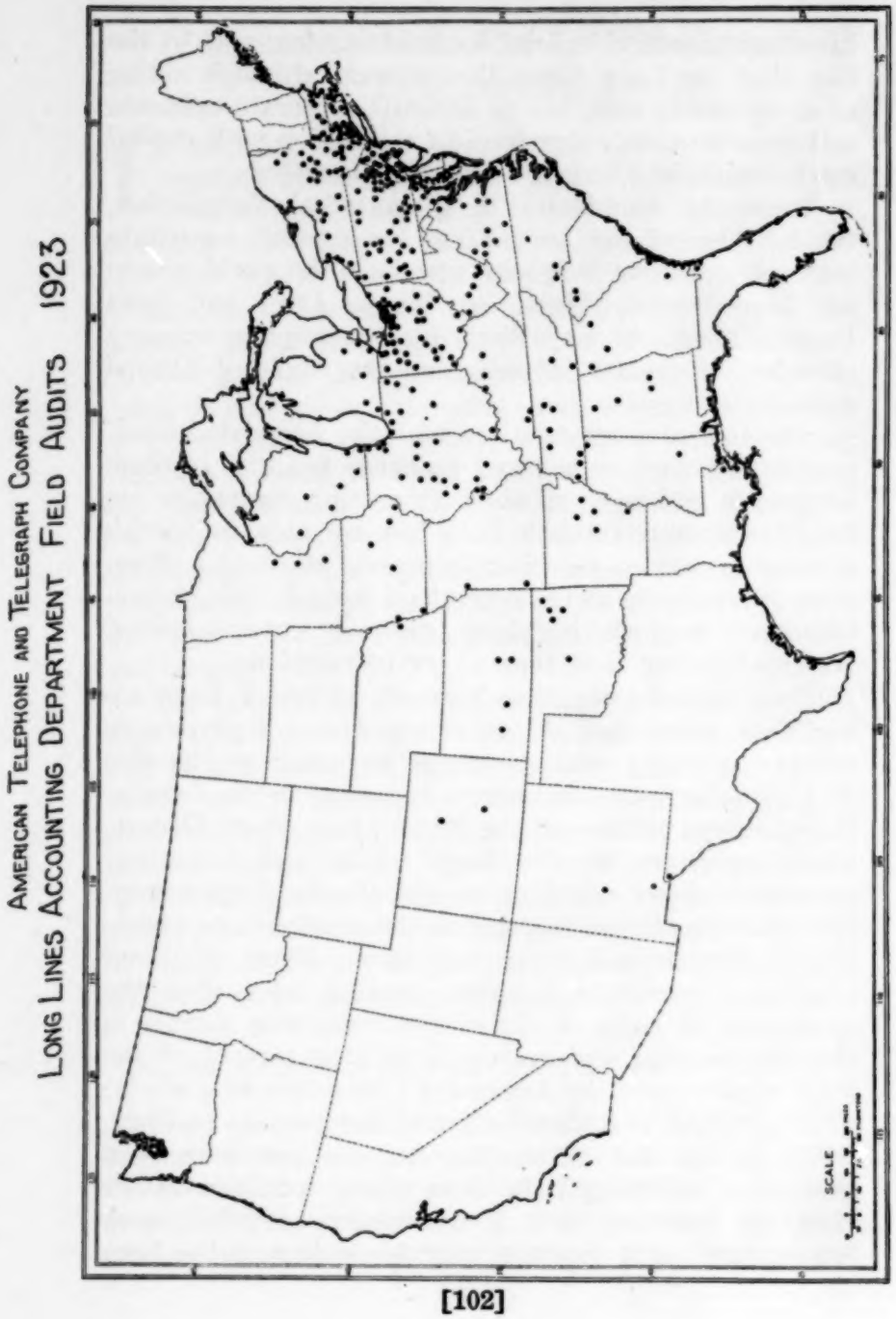
Lines message and special contract service, and to the fact that the Long Lines Department, although acting as an operating unit, has no separate corporate existence and no accounting, therefore, in connection with capital stock, bonds, and certain other related matters.

From the standpoint of geographical distribution, the toll lines of the Long Lines Department constitute the most extensive telephone system in the world, reaching from Boston, Mass., to Yuma, Ariz., and from Duluth, Minn., to Key West, Fla., covering a territory considerably greater in area than the whole of Europe exclusive of Russia.

Through contract relations with the Associated Companies, whereby the toll and exchange facilities of these companies and those of their connecting companies are linked with our through lines, we are able to furnish a message service reaching thousands of central offices from Nova Scotia to California and from British Columbia to Cuba, making long distance communication possible between more than 15,000,000 stations.

Over this far-reaching network of trunk lines are scattered more than 10,000 Long Lines employees in widely separated groups,—gangs reporting to the five division offices, section linemen reporting to the twenty-three district offices of the Long Lines Plant Department, operators at the larger cities and important switching points reporting to the Traffic Department, and other employees engaged in the construction, operation and maintenance of our lines. These scattered employees constitute a larger working force than the employees of eight of the sixteen operating groups in the Bell System and are equal to four percent of the total employees of the Associated Companies as a whole.

Due to the wide distribution of our message business, which makes our accounting for message revenue a matter of collecting data from many localities rather than the handling of a great volume of detail work concentrated at a comparatively few points, it has been


AMERICAN TELEPHONE AND TELEGRAPH COMPANY
LONG LINES ACCOUNTING DEPARTMENT FIELD AUDITS 1923
SCALE

found desirable to have the billing and reporting of this business done by the Associated Companies at their revenue accounting centers, instead of attempting to do this work at division offices of our own. There is also a decided advantage, from the standpoint of the subscriber as well as from the standpoint of the Company, in having all charges for telephone service included in one monthly bill instead of rendering one bill for Long Lines messages and another bill for exchange service and local toll calls.

Accounting for Long Lines Message Service

The first step in the accounting for our message revenue is the writing of the toll ticket. This takes place at the toll centers, of which there are about 3,400 where Long Lines messages originating at 85,000 points are recorded. The tickets are then sent to revenue accounting centers for reporting and billing, and, although some of this work is done at the accounting offices of connecting companies, most of it is handled at the seventy-five revenue accounting centers of the Associated Companies, which also receive and tabulate the reports sent in by the connecting companies.

Each revenue accounting center maintains a current record of tickets from which are prepared the monthly toll reports which show by terminating toll centers the distribution of messages and revenue for business from each originating toll center. There are about three thousand of these toll reports each month which are grouped by the Associated Companies into forty-five summaries each of which represents the Long Lines business originating in a particular geographical area.

For each of these areas a monthly statement is made showing the total revenue from Long Lines message business originating in the area and the amount retained by the Associated Company principally as compensation for services and facilities furnished by it in handling

message business and for line facilities furnished in connection with both message and special contract business. This statement together with the underlying toll reports is forwarded to the Long Lines Accounting Department and forms the basis of settlement between the two companies.

One of the principal uses of the data contained in the monthly toll reports is in Commercial and Traffic Engineering studies to determine the new construction necessary and to secure the most efficient use of existing plant. For this purpose the Accounting Department maintains for use by the Traffic and Commercial Departments records showing the number of Long Lines messages between some 6,000 pairs of toll centers and the toll revenue originated at about 1,500 toll centers, the combined records comprising more than 20,000 cards.

In order to reduce the work of the Associated Companies in reporting our message business, it has been our policy to require currently only such information as is necessary for settlement computations and for these engineering studies, with the understanding that detailed audits of the methods and accuracy of the field reporting work will be made through visits of our representatives to the revenue accounting and toll centers.

These field inspections are necessarily confined to a large extent to current work and include the examination of the lost call files at the larger toll centers to make sure that these files do not contain unbilled messages or report charges; the verification of the charges shown on Long Lines tickets, including a check of the length of conversation and class of service; the proper separation of Long Lines and local toll business in the reports prepared by the Associated Companies and in the reports which they receive from their connecting companies; and the inspection of the approvals underlying claims for adjustments and uncollectibles. These audits have proven very helpful not only in safeguarding the proper billing and reporting of Long Lines messages, but also

in standardizing practices in the field offices. As a result of inspection of the rating work at a number of offices, more convenient local rating records are being prepared. Considerable study has also been given to the question of developing standard rating practices by which it is expected to secure more accurate rating with a possible reduction in cost.

Some of the distinctive features of Long Lines message revenue are the high average gross revenue per message, the large percentage of calls handled on a differential rate basis and the correspondingly large number of chargeable reports, the problem of collection in the case of messages originating at coin-boxes where the coin-box code has to be passed to several operators before reaching the line operator who supervises the collecting, and certain difficulties experienced in the handling of collect calls due to the mailing of the outward collect ticket to distant accounting offices.

Accounting for Special Contract Service

Although the Long Lines Department has no exchange service, and consequently none of the problems of exchange service accounting, we have a large development of what is known as special contract service, covering the use of our facilities for telephone or telegraph service between contract points for those users who, on account of the volume of their business, desire service between the same points either continuously or at stated periods. All of the accounting in connection with this service, including the rendering of bills against the subscribers, is handled by the Long Lines Accounting Department.

Special Contract Service is furnished at about 650 points in the United States, Canada and Cuba. The service furnished under these contracts plays a large part in the daily life of the nation, distributing price quotations to the stock and produce markets through-

out the country, affording direct communication between the factories and selling offices of great industries, and carrying a large portion of the news which appears in the daily papers from Coast to Coast.

During 1923 we rendered 13,000 bills covering this service. Special care is necessary in preparing these bills because of the frequent changes in service, caused by the rearrangement of circuits requested by customers, as well as credits for unavoidable interruptions due to storms and additional charges for overtime and temporary service. Collections for this service are made by six Long Lines commercial offices, located at Boston, New York, Philadelphia, Atlanta, Cleveland and Chicago. A modified stub-accounting system has been adopted for the subscribers' accounts, the Accounting Department copy of the subscriber's bill showing the payments made and the unpaid balances, record of payment being obtained from the detailed collection reports sent in by the commercial offices.

Inter–Company Billing

One of the special features of Long Lines accounting is that, through our settlement and other accounting relations, we have a close contact with all of the Associated Companies as well as with the Bell Telephone Company of Canada and the Cuban and Cuban-American Companies. Where economies of investment or operation can be effected, arrangements are made for the interchange of facilities and services, the latter embracing operation as well as construction and maintenance. During 1923 approximately 21,000 bills were rendered against the Long Lines Department by the Associated Companies covering these items and over 5,000 bills were rendered by the Long Lines Department against the Associated Companies.

During the past year we also received some 70,000

bills from the Western Electric Company covering materials and installation services in connection with our construction and maintenance program. These bills, together with the bills rendered by the Associated Companies, reach the Accounting Department through the field offices of the Plant Department where the accounting classifications are determined and summarized and the necessary approvals obtained. The bills are paid by the Treasurer of the Long Lines Department on receipt of the final vouchers prepared by the Accounting Department.

Field Disbursements

While the bills of the Associated Companies and the Western Electric Company are paid from New York out of the funds of the Long Lines Treasurer, it is necessary to pay the wages of our employees, as well as certain expenses incurred by them, such as board and lodging, traveling, etc., out of field funds. For this purpose, a large number of cash advances have been granted to local cashiers and field employees who make the required field disbursements. At regular intervals these advance holders prepare statements of their payments, which together with the approved payrolls and pay receipts or other evidence of payment are sent through to the Accounting Department for final audit and reimbursement through orders on the Treasurer.

The payrolls and individual pay receipts used by the advance holders in connection with the payment of wages are stencilled in the Accounting Department. In the course of a year we distribute about 4500 weekly and monthly payrolls supported by more than half a million pay receipts. After the payrolls are completed and paid they are returned to the Accounting Department for audit and reimbursement. The amounts paid are entered on individual income cards which form the basis of the information furnished the Federal Govern-

ment and several of the States under the provisions of income tax requirements. This record is also useful in compiling employment statistics required by industrial commissions in many states.

The Accounting Department arranges for the bonding of advance holders and audits their working advance accounts from time to time through its traveling auditors. Nearly one thousand audits were made of these field funds during 1923, our traveling auditors visiting a large majority of the employees entrusted with Company funds. The employees whose accounts were audited were located at 308 different points in thirty-three states. In addition to their audits of the working advances, the traveling auditors make field verifications of selected expense vouchers.

Administrative Accounting

It is necessary, of course, for the wages and other field disbursements, as well as the material which is used from Company purchases, to be charged to the proper investment and operating accounts. For departments other than the Plant, this is a fairly simple procedure, since the various employees perform about the same kind of service daily. In the Plant Department, however, the distribution is more difficult and the accounting is based upon descriptive daily and weekly work reports prepared by the division gangs, section linemen, equipment attendants, etc. About 190,000 of these work reports, which are prepared for supervisory purposes and for the maintenance of line records as well as for their accounting use, are submitted by the working forces during the year to the district and division offices which determine the accounting distribution from the details of time, work accomplished, and material used as shown by these reports. Our plan is to require only a general knowledge of our accounts on the part of the working groups, relying upon

the trained clerical forces in the district and division offices to properly classify the amounts from a full and definite description of what was done.

The field accounting work which is carried on by the different sub-departments of the Long Lines, especially the Plant Department, closely resembles the general practice of administrative accounting in use throughout the Bell System. Under this plan, the various sub-departments, such as the Plant, Traffic, Legal, Commercial and Engineering, classify their own expenditures to the established Company accounts as prescribed by the Accounting Department with such additional details as are required for local supervisory purposes, and send to the Accounting Department monthly summaries of the accounting classifications for entry to the general books and auxiliary records.

About sixty different offices participate in this administrative accounting work and a total of fifty-two summaries are prepared and sent to the Accounting Department each month. These summaries show the accounting distribution in connection with the payment of wages, sundry disbursements, bills received from the Associated Companies and certain bills rendered against the Associated Companies, bills for services by and purchases from the Western Electric Company, the movement of material, and changes in plant values through replacement work.

To assure compliance with prescribed accounting practices and to determine the accuracy of the field accounting work, traveling representatives of the Accounting Department examine at least one month's accounting work at each of the Plant Department offices each year as well as make occasional inspections of the accounting done by other sub-departments.

Financial and Other Reports

Although our accounting detail originates at many scattered points,—toll centers, revenue accounting offices

of the Associated Companies and field offices of the Long Lines Department, the final results of each month's work are brought together in the general books of the Company in the Accounting Department and are reflected in the Company reports.

The monthly reports issued by the Long Lines Accounting Department consist of the usual balance sheet and income statement together with a number of supplementary reports giving further details of some of the principal items in the the two fundamental statements, also a report comparing the actual result of all the activities of the Long Lines Department with the provisional estimate. These reports are sent to the Comptroller, the Long Lines Board—corresponding to the Board of Directors of an Associated Company—and to various executives and operating officials. In addition, a number of departmental and special reports are issued analyzing the expenses of the different subdepartments and presenting other statistical data relative to matters of current interest to our executives.

Because of the wide distribution of our plant, it is necessary to prepare many reports and statements covering data required for taxation or regulatory purposes. Altogether, our books show a plant investment in forty-two states, thirty-one of which require returns for taxation involving the computation of the gross revenue earned within those states.

Labor and industrial commissions in various states also require detailed statements covering information relative to wages, working conditions and general employment matters. The preparation of some of these reports involves considerable work; for example, one state requires a report showing the grouping of employees by sex, age, occupation and wages, separate returns being necessary for twenty of the counties in the state as well as a consolidated return for the remaining counties.

The Accounting Department also does considerable work in connection with the annual census of Long Lines

employees, which constitutes a part of the Bell System census as consolidated by the Chief Statistician. The census shows the age, term of service, occupational grouping and wage of all employees on the payroll for a selected week.

Statistical Service and Methods Work

An important development at the present time among the Accounting Departments of the Bell System is along the lines of rendering a more complete statistical service to executives and officials who are responsible for the policies and operating results of the different Companies. More and more these executives are turning to the Accounting organizations for information which will assist them in solving problems of operation and in planning for the future.

Much of this information is distributed in graphic form. Some of the recent activities of the Long Lines Accounting Department along these lines have been the development of a series of charts showing fundamental Long Lines conditions and trends; the preparation of a number of pocket-binders containing charts and statistical data for the executives and heads of the sub-departments; data and charts in connection with the five year budget; and special studies covering the distribution and growth of our business, personnel conditions, and other matters of current interest. We are also experimenting with the use of graphic supplements in connection with our monthly reports.

Although most of our statistical services have been directed toward furnishing data for executive use, we have developed to some extent the use of graphics in educational work and during the past year prepared a number of "Accounting Department Exhibits" illustrating the volume and principal steps of Long Lines Accounting and its relation to the activities of the Company as a whole. These exhibits were made available for the employees of all the sub-departments.

Efficiency demands that in accounting as well as in other activities of the business the work be done in the manner and at such point in the organization as will yield the desired results in the most economical way. The wide spread of Long Lines plant and business affords many opportunities for judicious choice in this respect and constant study is given to the development of satisfactory methods of procedure. The methods section of the Accounting Department studies all new requirements and special conditions and provides the necessary routines and instructions for handling the accounting work by our own people and by the field offices. This includes the application to Long Lines conditions of general rulings and principles prescribed by the Comptroller, and also much original research work due to the distinctive problems that arise in Long Lines accounting.

In the work of collecting data and compiling reports or making special studies, there is kept in mind the objective of an analytical and constructive picture of Long Lines business. To the extent that we accomplish this, we fulfill the thought expressed by President Thayer at the General Accounting Conference when he referred to the Accounting Departments of the Bell System as the "fact-interpreting" and "fact-distributing" as well as the "fact-gathering" department of the business.

C. MORSACK.

The Radio Broadcasting Situation

A Statement to Stockholders of the American Telephone & Telegraph Company issued on March 25, 1924, by President H. B. Thayer.

IN view of the conflicting accounts and interpretations of the suits recently instituted by the company to protect its patents affecting radio telephone broadcasting, it will perhaps be helpful to relate the circumstances that resulted in the present patent situation.

Some time before the war the Bell System research laboratories began development of what is now called the vacuum tube, as a long distance wire telephone amplifier or repeater. It was this development that made possible transcontinental telephony.

The laboratories of the General Electric Company had also undertaken the development of this apparatus for other purposes.

As was inevitable, with two great experimental laboratories engaged in similar research, each company acquired inventions and improvements of mutual usefulness.

Patent Considerations Put Aside During War

With the coming of the war and the paramount requirements of the Army and Navy in the field of communications, each company put aside considerations of patent ownership, and there was rapid cooperative development of this apparatus in its application to transmission by wire and wireless.

When the end of the war ended the necessity for this emergency disregard of patent rights, a valuable art had been developed which no one in the business of communications could use without infringing upon the rights of others.

Under such conditions there could be no further manufacturing of certain apparatus, nor further devel-

opment of this art, and the Navy Department of our government requested this company and the General Electric Company to try and relieve the situation for the general welfare.

In response to this request, negotiations were initiated and carried through to an arrangement of cross licenses to which other owners of patents in this field were afterward admitted. For practical operation under this arrangement, it was necessary that the parties to the agreement be given the specific uses of the apparatus in question that were logical to their business.

It was in this way that licenses for certain uses in connection with radio telephony came to us, as our directors reported to the stockholders at the time.

The Company's Fundamental Purpose

This company's prime purpose in operating under these licenses has been such development of the radio art as would be useful in relation to telephone service.

Actuated by this prime purpose, we established an experimental broadcasting station in New York in order to be better able to study not only radio transmission problems, but also public taste in broadcast entertainment, and to furnish advice to our Associated Companies with respect thereto.

By this time there was widespread popular interest in broadcasting, as was evidenced by the growth of the industry furnishing apparatus for radio reception. A realization of the extent of this interest led to a sudden demand for broadcasting stations from individuals and concerns wishing to establish a contact with the public for their own benefit by means of matter transmitted through the ether.

Consideration of many of these applications disclosed that all of the economic factors involved, as well as the high costs of operation and maintenance, had not been fully realized. It was apparent that if there were a

large sale of broadcasting apparatus, some purchasers would experience disappointing results. It was also clear that a multitude of stations would create a condition of congestion that would certainly lessen, and might possibly destroy, the value of broadcasting to the public.

From the financial standpoint it would have been profitable to manufacture and install all the broadcasting apparatus sought for. We deemed it a better policy, however, to point out all the factors and risks of the situation, and for those wishing to broadcast, to offer our own station at moderate rates, so far as our allotted time limits for broadcasting would permit.

We are confident that by thus assisting in checking tendencies that were putting the future of broadcasting in jeopardy, we have acted only in the best interests of the public.

Development Relating to Broadcasting

Broadcasting is made possible by inventions that have cost their owners large sums not only in acquiring patents, but also in experimental and development expense. We have recognized the fact that many broadcasters, in making wrongful use of our inventions, have been ignorant of their infringement. We have, therefore, established reasonable license fees, the payment of which, coupled with an agreement to refrain from further infringement, would liquidate any claims for infringement and would give the broadcaster a legal right to the use of the patents during their life. The fees are so moderate as to represent a return far below the customary profits on unpatented electrical apparatus.

Business Prudence Dictated Patent Suits

With approximately 400 stations in the United States using our inventions without a license from us, it became a matter of ordinary prudence for us to institute

legal proceedings that would establish our ownership of patents and our rights as owners. Not to protect them would be sheer neglect of duty.

For an initial suit we decided to select a nearby station so as to minimize the costs to both parties concerned. Pursuant to this plan, we respectfully called to the attention of the owners of a station in New York, the nature and extent of their infringement, listing many of the patents involved. Our notification was ignored and suit was brought.

A suit was also brought against another defendant in relation to methods of sending programs of entertainment along wires, which methods we believe infringe upon our patents and which might interfere with operation of neighboring telephone service. Obviously, this suit is also a matter of plain business prudence.

The Company's Purposes in the Field of Radio Broadcasting

We have been asked what our future policy will be in connection with radio broadcasting. The art of radio broadcasting is new and changing. Speculation as to the future is difficult and futile. The new problems which are constantly presenting themselves are being given the closest study, but the details of our plans could only develop as the art develops. The general guiding principles are not likely to change. They are: that we keep in and abreast of the development of the art and that we encourage in every way possible such development by others. We shall make it possible, so far as lies with us, for any one to secure broadcasting apparatus at moderate prices; and for those broadcasters who are now infringing our patents, to continue their use under reasonable and moderate terms. For the present we shall continue to operate our own experimental broadcasting station, making its facilities available under reasonable rules, in the public interest, for

those who wish to test broadcasting as a medium for attracting the public's notice. Far from desiring the sole responsibility for broadcasting, it is our strong belief that, in the public's interest and in our own interest, nothing should be allowed to interfere with any development of it that may be proved to be beneficial. We heartily favor government control of such activities and the federal legislation that is pending has our cordial support.

A monopoly, either of broadcasting for entertainment of the public or for hire is not desirable from any point of view. There has been no danger and is no danger of such a monopoly.

H. B. THAYER.

Organization Changes

American Telephone and Telegraph Company

C. M. Bracelen elected Vice President and General Solicitor.

Assistant Attorney, American Telephone and Telegraph Company, January 1, 1918; Attorney (General Department) and Attorney (Long Lines Department,) 1919; General Solicitor (General Department) and General Solicitor (Long Lines Department) 1921.

E. H. Colpitts appointed Assistant Vice President.

Mechanical Department, American Bell Telephone Company and Engineering Department, American Telephone and Telegraph Company, 1899–1907; Engineering Department, Western Electric Company, 1907–1924; Assistant Chief Engineer, Western Electric Company, 1918–1924. Development and Research Department, American Telephone and Telegraph Company, 1924.

Abstracts of Recent Technical Papers from Bell System Sources

Telephone Transformers,[1] by W. L. Casper. After outlining the varied sets of conditions which different types of telephone transformers must meet, this paper discusses the design and construction of transformers to handle efficiently the range of frequencies ordinarily present in speech. Two winding transformers only are dealt with, and the three most common impedance combinations of the two circuits connected by the transformer are considered; namely, both circuits comprised of resistances, one circuit a resistance, and the other a positive reactance, and one circuit a resistance and the other a negative reactance.

The efficiency with which energy is transmitted is measured by comparison with an ideal transformer, and the transformer is studied by supposing it replaced by an equivalent T network. The variation of transformer losses with frequency is discussed and characteristic curves are shown for transformers of different mutual impedances. Characteristics are also given showing the operation of the in-put transformer associated with the vacuum tube.

The mechanical construction of the common battery repeating coil, telephone induction coil, and of certain types of transformers for vacuum tube circuits, are shown. These transformers are all constructed so as to give the desired accuracy of speech transmission under their respective circuit conditions.

Relays in The Bell System,[2] by S. P. Shackleton and H. W. Purcell. Before they can converse people must either be brought together or virtually be brought into one another's presence by the telephone. Any telephone system must establish talking connec-

[1] Journal of the American Institute of Electrical Engineers, Vol. XLIII, p. 197, 1924.

[2] Bell System Technical Journal, Vol. III, p. 1, 1924.

tions between its subscribers, and these connections must be built up, supervised and disconnected when desired. This work is accomplished by the use of relays of various kinds, and the speed and accuracy of service is largely dependent upon them. There are completed daily in the Bell System about 42,000,000 telephone calls. These involve the successful and accurate operation of over one and one-half billion contact connections daily.

Many kinds of relays are employed in the Bell System, varying from the simple electromagnetic drop to the sequence switch, the thermionic vacuum tube and the panel selector. Today a circuit connection between two subscribers served by manual exchanges in a large multi-office district involves about 21 relays. When these subscribers are served by machine switching offices, the number of relays in a local connection may be as great as 146. It not infrequently happens that in setting up a toll connection more than 300 relays are employed.

In this paper the relay developments leading up to, and making possible the present communication system, are outlined with particular reference to electromagnetic relays. A few typical circuit applications are given with a discussion of the requirements imposed upon relays which influence their design. Several types of relays are illustrated and their distinctive features are described.

Some Applications of Statistical Methods to the Analysis of Physical and Engineering Data,[3] by W. A. Shewhart. Measurement of any physical quantity customarily yields as many different values as there are observations. From a consideration of these measurements the most probable value must be determined, and also how an observation may be expected to vary from this most probable value, and the reasons why it varies in the particular way it does. In other words, the real

[3] Bell System Technical Journal, Vol. III, p. 43, 1924.

value of physical measurements lies in the fact that from them it is possible to determine something of the nature of the results to be expected if the series of observations is repeated. The best use can be made of the data if we can find from them the most probable frequency or occurrence of any observed magnitude of the physical quantity or, in other words, the most probable law of distribution.

It is customary practice in connection with physical and engineering measurements to assume that the arithmetic mean of the observations is the most probable value and that the frequency of occurrence of deviations from this mean is in accord with the Gaussian or normal law of error which lies at the foundation of the theory of errors. In most of those cases where the observed distributions of deviations have been compared with the theoretical ones based on the assumption of this law, it has been found highly improbable that the groups of observations could have arisen from systems of causes consistent with the normal law. Furthermore, even upon an a priori basis the normal law is a very limited case of a more generalized one.

Therefore, in order to find the probability of the occurrence of a deviation of a given magnitude, it is necessary in most instances to find the theoretical distribution which is more probable than that given by the normal law. The present paper deals with the application of elementary statistical methods for finding this best frequency distribution of the deviations. It points out some of the limitations of the theory of errors, based upon the normal law, in the analysis of physical and engineering data; it suggests methods for overcoming these difficulties by basing the analysis upon a more generalized law of error; it reviews the methods for finding the best theoretical distribution and closes with a discussion of the magnitude of the advantages to be gained by either the physicist or the engineer from an application of the methods reviewed herein.

Certain Factors Affecting Telegraph Speed,[4] by H. Nyquist. This paper considers two fundamental factors entering into the maximum speed of transmission of intelligence by telegraph. These factors are signal shaping and choice of codes. The first is concerned with the best wave shape to be impressed on the transmitting medium so as to permit of greater speed without undue interference either in the circuit under consideration or in those adjacent, while the latter deals with the choice of codes which will permit of transmitting a maximum amount of intelligence with a given number of signal elements.

It is shown that the wave shape depends somewhat on the type of circuit over which intelligence is to be transmitted and that for most cases the optimum wave is neither rectangular nor a half cycle sine wave as is frequently used but a wave of special form produced by sending a simple rectangular wave through a suitable filter. However, there are conditions where the cost of a special filter is hardly warranted, in which the simple rectangular form is used.

Considerations of the choice of codes show that while it is desirable to use those involving more than two current values, there are limitations which prevent a large number of current values being used. A table of comparisons shows the relative speed efficiencies of various codes proposed. It is shown that no advantages result from the use of a sine wave for telegraph transmission as proposed by Squier and others and that their arguments are based on erroneous assumptions.

The Auditory Masking of One Pure Tone By Another and Its Probable Relation to the Dynamics of the Inner Ear,[5] by R. L. Wegel and C. E. Lane. The authors used an air damped telephone receiver supplied with variable currents of two frequencies and determined the amount of masking by tones of frequency 200 to

[4] Journ. A. I. E. E. Vol. XLIII, p. 124, 1924; Bell System Technical Journal, Vol. III, April, 1924.

[5] Physical Review, II, Vol. XXIII, p. 266, 1924.

3500 for frequencies from 150 to 5000. Except when the frequencies are so close together as to produce beats the masking is greatest for tones nearly alike. When the masking tone is loud it masks tones of higher frequency better than those of frequency lower than itself. If the masking tone is introduced into the opposite ear the effect occurs only by virtue of conduction through the bones of the head.

It is shown that combinational tones result when two tones of sufficient intensity are introduced simultaneously, these combinational tones being due to a non-linear response of the ear.

A dynamical theory of the cochlea is given which ascribes pitch discrimination to a passing of vibrations along the basilar membrane and a shunting through narrow regions of the membrane at points depending on the frequency. This view of the action of the ear offers an explanation of the masking effects.

Radio Telephone Signaling—Low Frequency System,[6] by C. S. Demarest, M. L. Almquist and L. M. Clement. The system described provides a means whereby any one of about seventy five radio stations operating on the same wave length may be called without signaling the remaining. This is an important improvement in the radio art for in many cases it permits a radio station operator to pursue other duties which would be impossible if he were required to listen in at all times. The engineering problem presented being remarkably similar to many telephone problems supplies an example of the accumulative value of research for the different pieces of apparatus involved were developed for wire telephony without thought as to their subsequent application to radio.

The apparatus is particularly free from interference such as the operation of nearby spark or I. C. W. stations so that the signaling system will continue to function satisfactorily although interference is so bad as to make

[6] Journ. A. I. E. E. Vol. XLIII, p. 210, 1924.

conversation impossible. As designed, the signaling system may be made an integral part of a standard radio system without altering the apparatus already in use.

High Quality Transmission and Reproduction of Speech and Music,[7] by W. H. Martin and Harvey Fletcher. Radio broadcasting has drawn attention to the problems involved in obtaining high quality in systems for the electrical transmission and reproduction of sound. This paper gives the general requirements for such systems, discusses briefly the factors to be considered in design and operation and indicates to what extent the desired results can be obtained with the means now available.

It was pointed out in this paper that broadcasting stations and connecting lines can be made practically perfect but that most of the loud speaking apparatus now extensively used for reproduction, causes distortion. At the time of reading this paper the authors demonstrated a laboratory model of a new loud speaker of unusual design. This apparatus reproduces all frequencies from the lowest to the highest of the audible range with approximately equal facility. This results in reproduced music which the ear can scarcely distinguish from the original.

An Electrical Frequency Analyzer,[8] by R. L. Wegel and C. R. Moore. Apparatus has been developed by means of which it is possible to measure and obtain a permanent record of the frequency components of an electric current wave. The device has two frequency ranges; 20 to 1250 cycles and 80 to 5000 cycles; the amount of power required does not in general exceed 500 microwatts; and the time necessary for making a record is about 5 minutes.

In principle, the process consists in feeding the complex wave to be analyzed into a selective network, the essential feature of which is a sharply tuned circuit whose frequency of tuning is controlled by varying the

[7] Journ. A. I. E. E. Vol. XLIII, p. 230, 1924.

[8] Presented at the Midwinter Convention, A. I. E. E.; printed in Bell System Technical Journal Vol. III, April, 1924.

capacitance in small steps with a pneumatic apparatus similar to that in a player piano. A maximum of response of the circuit occurs at each frequency of tuning which coincides with a component of the complex wave. An automatic photographic recorder of the response to each frequency of tuning, is provided by means of which the frequency and magnitude of each component of the complex wave may be obtained. For convenience of operation, an automatic control apparatus is provided, so that it is only necessary to connect the complex source or sources to be analyzed and press a starting button. The completed record of the analysis is delivered after the machine has passed through the entire range of frequencies.

The application has so far been principally to problems in the communication field such as the analysis of performance and distortion at audio frequencies of vacuum tube and mechanical oscillators and amplifiers, analysis of complex telephone waves and speech sounds, and the effect on a complex wave of transmission through electrical and acoustic apparatus. In the power field many applications are obvious, such as for example, quantitative comparison as to frequency content of the voltage and current supplied to and delivered by transformers, voltage and magnetic flux studies in generators and motors, commutation, and the effect of wave-shapes in power transmission line problems and control apparatus.

Distribution of Radio Waves from Broadcasting Stations over City Districts,[9] by Ralph Bown and G. D. Gillett. This is a description and analysis of the results obtained in a radio transmission survey of the cities of New York and Washington, D. C., and contiguous territory. Measurements of the field strength of radio signals from stations WCAP at Washington and WEAF at New York were made at a large number of points. Based on these data, curves are drawn showing how

[9] Presented to the Institute of Radio Engineers, January 16, 1924, at New York.

different kinds of territory cause different attenuations and showing radio shadows caused by mountains and by large masses of steel buildings. In order to visualize the phenomena, the data have also been plotted on maps, contour lines of equal signal strength being drawn. These contour maps illustrate graphically the non-uniformity of transmission in city areas and show the nature and extent of the "dead spots" and shadows.

A Primary Standard of Light Following the Proposal of Waidner and Burgess,[10] by Herbert E. Ives. The primary standard of light proposed in this paper consists of a black body constructed of platinum; the light from which, at its melting point, constitutes the photometric fixed point desired. The platinum black body consists of a cylinder of highly polished platinum with a narrow slit for observing the interior. Studies of the optical properties of reflecting cylindrical enclosures show that at certain angles of observation the interior is practically "black." The platinum cylinders are heated electrically and the light from the interior is observed by throwing an image of the slit on to a photometer field. Two series of observations were made, one by a visual photometric method, the other by a photoelectric cell giving a photographic record by means of a string electrometer. The two methods of observation gave practically identical results, yielding a final value for the brightness of the black body at the melting point of platinum of 55.4 candle power per square centimeter. The advantages of this proposed standard over the present unsatisfactory flame standards are discussed.

Deviation of Random Samples from Average Conditions and Significance to Traffic Men,[11] by E. C. Molina and R. P. Crowell. In this paper is discussed the significance of the theory of probability in connection with

[10] Journ. Franklin Institute, Vol. CXCVII, p. 147, p. 359, 1924.
[11] Bell System Technical Journal, Vol. III, p. 88, 1924.

the interpretation of traffic records by the men using them. These traffic records are in practically all cases analyses of samples selected at random and in most cases represent only small proportions of the whole of which they are assumed to be representative. The interpretation of these records depends on the understanding of the principles governing the probability of the deviation of the results of these analyses from an accurate measure of the whole. Through the discussion of certain aspects of the theory of a posteriori probability, considerable light is thrown on the extent to which the size of the sample is a factor in the conclusions to be drawn. Certain rather broad indications are developed to the effect that the representativeness of the results of the sample analyses depends chiefly on the number of samples studied. Two sets of curves were also developed showing the probable range of true frequency as compared with the number of observations. These curves present in rather simple form a means by which the traffic men can obtain an indication of the value of the results obtained from the analysis of sample records.

Measuring Methods for Maintaining the Transmission Efficiency of Telephone Circuits,[12] by F. H. Best. The circuits involved in the transmission of speech in a modern telephone plant, particularly those designed for long distance operation, necessarily involve a considerable amount of complexity. The use of telephone repeaters, the development of long toll cables, the application of carrier systems and other developments associated with these, while increasing the efficiency and economy of telephone toll circuits have also increased their complexity and have required the development of more effective means of insuring that the circuits are maintained at all times in good condition and adjustment.

Maintenance of the transmission efficiency of the telephone plant is conducted by a special force, using

[12] Journ. A. I. E. E. Vol. XLIII, p. 136, 1924.

methods and apparatus that have been developed for this purpose. This paper gives a brief description of the transmission characteristics of some of the common type of telephone circuits, outlines a general method for measuring their transmission efficiency and describes several of the most modern types of transmission measuring sets, together with a brief mention of the oscillators which supply the power for testing.

Notes on Recent Occurrences

SOUTHERN TRANSCONTINENTAL LINE

THE new Southern Transcontinental Line—a through route from Denver to Los Angeles by way of El Paso, Tucson and Phoenix—was placed in service on the afternoon of December 22, 1923 and a Chicago-Los Angeles circuit connected up just in time to carry its share of the heavy holiday traffic to and from the southwestern section of the United States.

This circuit, a non-loaded 165 side circuit 2937 miles in length, is the longest through circuit in the world. It is more than 500 miles longer than the Chicago-San Francisco circuit, more than 1200 miles longer than the New York-Havana circuit, and more than 1500 miles longer than the New York-New Orleans circuit. The longest known through circuits in any country of Europe, from Berlin to Essen, 342 miles, and from London to Glasgow, 418 miles, do not compare with it in length.

Thirteen through line telephone repeaters, installed in the circuit, give it a normal transmission equivalent of twelve miles of standard cable.

At night, when the long-haul traffic handled over this route is heaviest, an additional through circuit from Chicago to Los Angeles is obtained by connecting together a Chicago-Denver, a Denver-El Paso and an El Paso-Los Angeles circuit.

The importance of the new route, from the service standpoint, is demonstrated by the traffic record of toll calls over the circuit in both directions, which shows that the calls filed and completed are not between Los Angeles, Chicago, New York and other large cities alone, but are widely scattered among a large number of smaller cities and villages at both ends of the route.

The engineering and construction of these long circuits was a noteworthy achievement. For a greater

part of the circuit the wires were run on existing pole lines, but two long stretches of entirely new poles were required, one covering seventy-five miles between Denver and Colorado Springs and the second, about ninety miles in length, between San Antonio and Rincon.

Among the most serious of the problems encountered, from the construction standpoint, was the difficulty of transporting the large amount of materials required. The varied topographical and climatic conditions met with in the course of the work may be understood when it is remembered that at one point—Raton Pass, near the Colorado-New Mexico border—the altitude is 7,600 feet; while at another—near Salton, just over the California boundary from Arizona—the line dips into a depression 200 feet below sea level. In building the line, the telephone construction trucks had to make their way over mountain roads, desert sands, lava beds, cactus country and arid lands reclaimed by irrigation.

The provision of facilities along this route is in line with the plans of the Bell System for permanent extensions of the trunk lines for nation-wide service which contemplate the provision of at least three main transcontinental routes with suitable north and south tie lines. One of the two new routes will extend from New Orleans and Dallas to El Paso, where it will connect with the route just completed. The other will run from Minneapolis via Fargo and Billings to Seattle.

In addition to the telephone circuits provided by the new route, telegraph circuits can be established over the 165 phantom group between Denver and Los Angeles.

DEMONSTRATION OF TRANSCONTINENTAL TELEPHONY

A DEMONSTRATION of transcontinental and international telephony, in conjunction with radio telephony, was given before the members of the Bond Men's Club of Chicago, at the Congress Hotel, Chicago, on the

evening of February 8, 1924, under the direction of Brigadier General John J. Carty, Vice President of the American Telephone and Telegraph Company, in charge of Development and Research.

A telephone circuit was set up between Havana, Cuba and San Francisco, a distance of more than 5,000 miles. From Chicago, Gen. Carty carried on conversations with representatives of the telephone companies in these two cities, and then "called the roll of the continent" by talking with Bell System representatives at each of twenty repeater stations on the circuit.

The diners at Chicago were enabled to hear the conversations and roll call, together with musical selections rendered at Havana and San Francisco, by means of loud speaker apparatus connected with the circuit. In addition, seven broadcasting stations were connected with the telephone line, and it is estimated that millions of people enjoyed the demonstration by radio. The stations thus connected were WEAF, New York, and WCAP, Washington, broadcasting stations of the Bell System; KPO, San Francisco; KLX, Oakland; WMAQ, Chicago; WJAR, Providence; and CWX, Havana.

More than 4,000 letters from radio enthusiasts, expressing their appreciation of the demonstration, were received by Station WEAF.

Preceding the demonstration David F. Houston, President of the Bell Telephone Securities Company, addressed the members of the Bond Club on the financial, material and physical resources of the Bell System which enable it to provide a nationwide telephone service such as the demonstration illustrated.

THE ANNUAL MEETING

THE annual meeting of the stockholders of the American Telephone and Telegraph Company was held at the headquarters building at 195 Broadway,

New York, on March 27th, and the directors were re-elected. Transactions of the past year were approved and only routine business came before the meeting.

The stockholders' representation was very satisfactory, there being 4,473,838 shares represented by 150 shareholders present in person and 156,922 shareholders represented by proxies.